

COLOR INHERITANCE IN NORTH AMERICAN YAKS

By Lawrence G. Richards October 15, 2010

There are only a few colors in Fullblood yaks in North America and only three color patterns. Their inheritance is relatively simple but not so easy to explain.

First it is necessary to separate patterns from color.

Color Patterns

There are three color patterns in North American yaks.

ROYALS are the spotted or pinto yaks. They are black and white or so called gold and white. They usually have a full white tail and pinto pattern throughout the torso with white usually continuous under the belly. They usually have a pink nose and a pink tongue. The face usually has a broad white stripe much like a Hereford. The amount of body white varies significantly from about 10% to less than 90%. I call the individuals that are mostly black Dark Royals. On occasion we will see some very small spots, but never what I would call a true roan. Some people have referred to this pattern as a Holstein type pattern but this is frankly erroneous. There is no similarity in the pattern or the inheritance.

TRIMS display some white frequently facial as a star or stripe and frequently lower rear legs and sometimes all four legs will have white socks and occasionally 1/3 to 1/2 of the tail will be white. We have seen full white tails. The amount of white does not determine if the animal is a trim. If the animal has a spot of white 1/2 inch in diameter it is a trim. Prince Allante had only a small white band above the coronet on one rear leg and he was indeed a Trim producing many Royals.

SOLIDS are completely solid with no white. There are no solid white full blood yaks in North America.

The pattern inheritance is very simple. ROYALS are Homozygous for the pinto color pattern. Trims are heterozygous for the color pattern and Solids are homozygous for solid pattern. The mode of inheritance is Incomplete Dominance where the Heterozygous genotype results in a partial expression that we designate as Trim phenotype. I will designate the ROYAL genotype as RR, the TRIM genotype as Rs and the SOLID genotype as ss.

ROYALS bred to ROYALS produce 100% ROYALS (RR)

ROYALS bred to SOLIDS produce 100% TRIMS (Rs)

ROYALS bred to TRIMS produce 50% ROYALS and 50% TRIMS

TRIMS bred to TRIMS produce 25% SOLIDS, 50% TRIMS and 25% ROYALS.

I presented this as a theory in The NEW YAK TIMES a prestigious scientific journal I published from 1991 to 1995. In reality the inheritance follows the theory in almost mathematical precision. In fact IF Mendel had been a ROYAL YAK breeder, he could have thrown his pea garden out the window!

As a final comment on North American yak color patterns, there are no Lineback full blood yaks and no Roan yaks in North America.

COLOR in NORTH AMERICAN YAKS

Recognized colors in North American yaks are BLACKS commonly called Grey Nosed or Dun. These are black hided animals with a grey nose and sometimes a grey dorsal stripe. They vary from a near dark black to brownish , but always have a grey or brownish nose. Galloway breeders consider these animals to be a black hided animal with a dun or dilution gene modifying the black expression of the primary color gene. They would call these animals duns.

IMPERIALS are the true black yaks with no grey. They have a shiny black nose and at birth are frequently coal black. This color frequently develops a reddish cast from sun exposure as they develop. However the most sought after persist with a coal black color into adulthood. The IMPERIALS also tend to have more shine or luster to their coats. The reddish cast maybe due to modifying genes or casting genes that act in the presence of the primary Imperial gene and interaction with sunlight to create the reddish cast.

The third color is GOLDEN. This is actually a misnomer as the animals are not really a golden color. Some Palomino horses are true golden animals, but many are not. Frenchmans Guy an extremely popular Champion Barrel Racing American Quarter Horse Stallion is a perfect example of a golden animal. Nevertheless, the animals designated as Golden yaks are a reddish brown color that varies from light red to more brownish red. It is inherited as a recessive trait that requires the homozygous genotype for phenotypic expression. The heterozygous state is not expressed, but is a recessive carrier. The inheritance is identical to the red gene in Red and Black Angus cattle.

COLOR INHERITANCE

To tie this all together I am going to assume that we have three color gene alleles that act at one primary loci or gene. This discussion acknowledges the existence of dun or dilution genes and modifying genes but that their action may be overridden by dominance at the primary gene location. It maybe an oversimplification to assume all the action occurs at one primary gene location but it will simplify the presentation. My codification is predicated on the net results and is not meant to delineate every possible modifying gene.

I will assign I for IMPERIAL, b for Grey nosed black and g for GOLDEN. The b and g are lower case as they are both dominated by IMPERIAL.

The DR. LOCK Theory of IMPERIAL INHERITANCE. In 2010 I finally realized how the IMPERIAL gene is inherited. DR. LOCK is a coal black IMPERIAL bull that as of this summer has produced over 30 IMPERIAL offspring. Every single female he has been bred to has produced an IMPERIAL calf, either SOLID or TRIM. The necessary conclusion is that DR LOCK is Homozygous for the IMPERIAL gene.

This explains why over the years when IMPERIAL bulls were bred to grey nosed yak cows from one-third to 50% of the calves were IMPERIAL. These bulls were Heterozygous for the IMPERIAL gene! Billy the Kid was sired by an IMPERIAL BULL (BILL the BULL) and his mother was a grey nosed female. So he could only be heterozygous for the IMPERIAL gene, if only one copy of the IMPERIAL gene is required to express the IMPERIAL phenotype. BILLY the KID would be a Heterozygous IMPERIAL (Ib) producing a mix of IMPERIAL and Grey Nosed offspring. DREADLOCK is another Heterozygous IMPERIAL (Ib) producing a mix of IMPERIAL and Grey Nosed offspring. DREADLOCK was sired by BILL the BULL and out of WOOLY BULLY a GREY NOSED female.

The conclusion is that only one copy of the IMPERIAL gene is required to dominate over the Grey Nosed gene and also the GOLDEN gene.

To be HOMOZYGOUS IMPERIAL Dr. LOCK would have received one copy of the IMPERIAL gene from his sire DREADLOCK and one copy of the IMPERIAL gene from his mother BLACKBERRY an IMPERIAL TRIM female who is probably also a HETEROZYGOUS IMPERIAL.

Previously, I had also thought that IMPERIAL bred to IMPERIAL would only produce IMPERIAL offspring. But this year two Imperials bred to each other produced a grey nosed calf. The conclusion is that both the bull and the female were heterozygous IMPERIALS each carrying the grey nosed black gene.

These then would be the COLOR GENOTYPES and their Phenotypic Expression:

Genotype	Phenotype
II Homozygous IMPERIAL	IMPERIAL
Ib Heterozygous IMPERIAL	IMPERIAL
bb Homozygous BLACK	GREY NOSED BLACK
bg Black/ Gold Carrier	GREY NOSED BLACK
gg Homozygous GOLD	GOLDEN
Ig IMPERIAL/ Gold Carrier	IMPERIAL

Now lets bring the Patterns and the Colors together;

Genotype	Phenotype
RRII Homozygous ROYAL/ Homozygous IMPERIAL	ROYAL but is the elusive IMPERIAL ROYAL
RRIb Homozygous ROYAL/ Heterozygous IMPERIAL	ROYAL but IMPERIAL ROYAL
RRbb Homozygous ROYAL/ Homozygous BLACK	ROYAL but GREYNOSED

These 3 Genotypes (all BLACK ROYALS) may not be distinguishable from each other as the ROYAL white would mostly mask the expression of IMPERIAL BLACK or GREY NOSED. I have a ROYAL with obvious grey on half her nose.

So here I have postulated the existence of an IMPERIAL ROYAL. This animal could produce IMPERIAL offspring when bred to non-IMPERIAL animals.

This summer (2010) Bill Martin of Far West Farms communicated to me that a ROYAL bull from an IMPERIAL TRIM cow produced an IMPERIAL TRIM calf when bred to a grey nosed cow. Provided his observation is correct, this ROYAL bull would then have been an IMPERIAL ROYAL and not just an intellectual construct. The bull now deceased is no longer available for genetic testing to confirm this observation. Despite my initial skepticism, this communication helped me evolve my present understanding of IMPERIAL inheritance. I would like to draw the reader's attention to the well-known cross of Black Angus bulls to Hereford cows producing Black Baldies. The facial white dominates over the black color, whereas throughout most of the torso the Angus black dominates over the Hereford red except perhaps the fringe areas of the underbelly and tail.

Genotype	Phenotype
RsII Heterozygous ROYAL/ Homozygous IMPERIAL	TRIM IMPERIAL
Rslb Heterozygous ROYAL/ Heterozygous IMPERIAL	TRIM IMPERIAL
Rsbb Heterozygous ROYAL/ Homozygous BLACK	GREY NOSE TRIM
RRgg Homozygous ROYAL/ Homozygous GOLD	GOLDEN ROYAL
RRbg Homozygous ROYAL/ Heterozygous GOLD	BLACK ROYAL/ gold carrier
Rsgg Heterozygous ROYAL/ Homozygous GOLD	GOLD TRIM
Rsbg Heterozygous ROYAL/ Heterozygous GOLD	GREY NOSED TRIM/ gold carrier
ssII Homozygous Solid/ Homozygous IMPERIAL	SOLID IMPERIAL
sslb Homozygous Solid/ Heterozygous IMPERIAL	SOLID IMPERIAL
ssbb Homozygous Solid/ Homozygous Black	SOLID GREY NOSED BLACK
ssgg Homozygous Solid/ Homozygous GOLD	SOLID GOLD
ssbg Homozygous Solid/ Heterozygous GOLD	SOLID GREYNOSED BLACK/ gold carrier

Conclusions

I have presented my 2010 conclusions that IMPERIALS are either HOMOZYGOUS or HETEROZYGOUS for the IMPERIAL gene and that the only the Heterozygous state is required for full expression of IMPERIAL color. I have concluded that DR LOCK is a HOMOZYGOUS IMPERIAL bull.

I have postulated the possibility that IMPERIAL ROYALS are a genetic possibility that may not be distinguishable in their phenotype from GREY NOSED BLACK ROYALS, but would be capable of producing IMPERIAL offspring even when bred to non-IMPERIALS. When I have produced such an animal you can be assured I will announce it.

The strategy to produce an IMPERIAL ROYAL would be to breed an IMPERIAL TRIM bull to a IMPERIAL TRIM female (or vice versa). If both parents were HOMOZYGOUS IMPERIAL TRIMS (RsII), then any ROYAL offspring would be IMPERIAL ROYALS; but remember ROYALS are only produced 25% of the time when TRIMS are mated to each other. If you understand these last two sentences then you fully understand this article and get an A on the test and pass with flying colours COLOR INHERITANCE IN NORTH AMERICAN YAKS 101.

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